Art. II.—*Further Notes on the Igneous Rocks of South Western Victoria.*

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(With Plate I.).

In the present paper I propose to supply a few additional details concerning some of the volcanic rocks described in a general manner a few years ago.[1]

Before doing so I wish to clear away a misapprehension which has arisen owing to the scheme of shading adopted in the map accompanying my former article. Both the olivine basalts and the typical sanidine-bearing series of rocks are there similarly shaded, not because I regarded them as identical, but simply because my researches were too imcomplete to enable me to define with even approximate accuracy their respective boundaries. As a fact, these two classes of rocks are so intimately associated in certain portions of the area that their separation can only be attempted on maps drawn to a large scale.

Since I drew attention to these rocks in 1893, the geology of the district has been reported upon by Mr. Ferguson, of the Geological Survey, who discovered a glacial deposit in the neighbourhood of Coleraine. Still later, Mr. E. G. Hogg has given a fuller account of the same deposit. and has besides examined the sanidine-bearing rocks with the result that he classes them as trachytes.

The first rock referred to by him occurs at Mounts Adam and Eve, and is described as light colored and porphyritic. It is of course a highly altered rock, and I gather from Mr. Hogg's subsequent remarks that his real type of the trachyte is the green, fresh-looking rock close at hand. Unaltered examples of such rocks are as a rule found only in the deeper quarries, since they weather readily and to a considerable depth from the

[1] Aust. Assoc. Adv. Sci., Adelaide, 1893.

surface. An extreme example of a decomposed trachytic rock is afforded by a hill locally called "The Giant Rock" which is, as I stated previously, now little more than a mass of kaolin, with occasional light colored, but still hard bands in the deeper seated portions. Near this, and undoubtedly an outlier of it, a huge stone, many tons in weight, outcrops, and is known to residents as "The Little Rock." The latter is hard, rough, brown in color, and similar both in macroscopic and microscopic characters to the rock from the Mount Eve quarry. The outlines of the larger crystals of sanidine are still preserved, but they are no longer clear and pellucid, as in less altered rocks. An analysis which I made of a sample from "The Little Rock," gave the following result :—

SiO_2	68·22	per cent.
Al_2O_3	16.89	,,
Fe_2O_3 / FeO	2·75	,,
CaO / MgO	traces	
K_2O	4·47	,,
Na_2O	5·30	,,
Loss on ignition	·95	,,
Total	98·58	,,

These two rocks are situated a few miles to the north of Mounts Adam and Eve on the Brit Brit Road. From a quarry not far distant I gathered the fissile, green, fresh-looking rock alluded to in my former paper as emitting a ringing sound when struck with the hammer. No chemical analysis has been made of it, but under the microscope it shews numerous lath-shaped sanidine crystals, with some tabular ones.

An excellent illustration of the changes effected in these trachytoid rocks by weathering was afforded some years ago, when an unusually deep as well as extensive quarry was opened near the Coleraine flour mill. Deep down, the rocks are greenish-black and much like a fine grained basalt in appearance, but above the weather line they become almost suddenly light grey or brown, and then might easily be mistaken for a metamorphic

sandstone. The microscopic structure of the unweathered rock at the base of the quarry has been previously given. Although this is undoubtedly a tolerably well preserved rock, I do not consider it typical of the trachytoid masses which cover so large an area to the north and west of Coleraine. The majority of my slides have been prepared from the rocks at Carapook, which is midway between Coleraine and Casterton. A quarry was opened here about 14 years ago to get stone for building a bridge over the creek, and the glistening crystals shewing on the clean cut surfaces of the blocks as they lay in a pile ready for use arrested my attention. This rock I traced to the quarry mentioned, which is situated on a rise about $1\frac{1}{2}$ miles north of Carapook, and in a line with the Den Hills outcrop a few miles to the east. In hand specimens it is dark green, fissile, almost smooth to the touch, and speckled by the light colored sanidine pervading it. Macroscopic crystals of sanidine are not only abundant in the rock, but they are usually so perfect that when extracted whole, which can frequently be done, the two cleavages parallel to P and M become plainly visible. Owing to the number and size of the macroscopic crystals in the rock, I was able to separate a sufficient weight of them from the matrix for a complete chemical analysis, which gave the following result :—

Sanidine Crystals, Carapook.

SiO_2	63·87	per cent.
Al_2O_3	22·82	,,
FeO	2·40	,,
CaO	·28	,,
MgO	·01	,,
K_2O	4·49	,,
Na_2O	6·16	,,
Loss on ignition	·57	,,
Total	100·60	,,

With this may be compared the following analysis of the rock in mass.

Carapook Rock.

SiO_2	63·37	per cent.
Al_2O_3	16·47	,,
Fe_2O_3	4·45	,,
FeO	1·21	,,
CaO	1·27	,,
MgO	·51	,,
K_2O	5·57	,,
Na_2O	5·88	,,
H_2O (direct weighing)	·76	,,
Total	99·49	,,

Sp. gr. 2·67.

Only 6·2 per cent. of the finely powdered rock is soluble in cold and 8·36 per cent. in hot hydrochloric acid.

The excess of soda over the potash in the sanidine crystals is noteworthy. As a similar result is obtained in the analysis of the rock in mass, it may be concluded that the large proportion of soda present in the latter is derived, mainly at least, from the sanidine, and not from any nepheline overlooked in the microscopic slides.

Nearly all the larger crystals embedded in the rock are thin-tabular, and usually shew only the face $\infty P\bar{\infty}$ (010), though I have also noticed faces in the zone oP (001)—$\infty P\bar{\infty}$ (100). They vary in size, but seldom exceed 4 or 5 mm. in length. The predominating clinopinacoidal faces are traversed by a number of irregular cracks which are sometimes curved, but generally roughly parallel to the orthopinacoid. These cracks are often filled with fine dusty matter of a brownish hue. Owing to the two easy cleavages respectively parallel to the base and clinopinacoid, as well as to the cracks just mentioned, very fine laminae sometimes separate when a slice of the rock with a crystal at the extreme edge is mounted: between crossed nicols such laminae extinguish nearly parallel to the most perfect cleavage. One of my Carapook slides shews a large porphyritic crystal twinned on the Carlsbad type, which, under polarized light, is very similar in appearance to the sanidine twin

in the phonolite from Wolf's Rock, Land's End, England, figured by Rosenbusch in Fig. 2, Plate XXIII. of his "Microscopic Physiography." Several of the cracks parallel to T, characteristic of sanidine, are conspicuous in each half of the twin and meet on the twinning line at an angle of about 150°. The cleavages parallel to P are only faintly visible, the section not being thin enough to shew them well. The separate halves of the twin extinguish at an angle of 8° with the twinning line and on the opposite side of it, the angle between the two extinctions being thus 16°. The smaller crystals of sanidine, which constitute in reality the mass of the rock, are usually broad and do not present well marked outlines.

In addition to the all pervading sanidine, a large number of columnar-shaped prisms of a green monoclinic mineral are scattered irregularly over the surface of the rock. Where the section is thinnest the green color is often discharged and the prisms then become brownish or almost colorless. They are practically without action upon polarized light, and, from their evident shelly structure, I am inclined to regard them as augite. Scattered throughout, there are also numerous minute grains of magnetite, usually rounded, but sometimes presenting sharp angles.

A few other outcrops of rocks with a generally trachytic aspect may be briefly noticed.

Nareen.—Amongst about a dozen slides prepared from the rocks of this locality, I find that the sanidines are mostly lath-shaped, rarely tabular, and exhibit fluxion structure. The rocks are, however, principally remarkable for the occurrence in them of opal, which appears to fill tolerably large spaces formerly occupied by other minerals, and mainly, I think, by the felspars. Usually it is without action on polarized light, but occasionally polarizes vividly in slender fibres radiating from a centre. This phenomenon is explained by Michel Lévy and Fouqué as due to contraction. Included in the opal there appear to be flakes, or rather nests, of tridymite, but on this point I am not certain. In hand specimens the rock is dark grey, and, though undoubtedly weathered, is still hard and tough. It is used locally as a building stone. The specific gravity of the rock is 2·44; the percentage of silica is 57·89 and of water 3·49. The other ingredients have not been finally estimated.

A similar rock, also with opaline enclosures, occurs in a creek at the foot of Den Hills, a few miles to the west.

Wando Dale.—Between Konong Wotong and Wando Dale there are three successive hills, or, rather, low ranges, over which the road passes. For some time they puzzled me as I drove across them, but a search revealed small outcrops of the usual trachytic rocks on all of them. Though the rocks themselves are certainly somewhat decomposed, the porphyritic sanidine crystals, which glisten on their surfaces, are of good size and very perfect. At the top of one of the hills blocks of brick red kaolin have been dug out and attract the attention of the curious. Close to Wando Dale Station the trachytic rocks rest directly on the crystalline schists, which are strongly developed in the bed of the River Wando, just below Mr. William Moody's house. On one occasion I travelled in a northerly direction from Phoines, near Carapook, through the romantic rocky scenery of Killiecrankie to Wando Dale, and for nearly the whole distance, about 13 miles, the trachytic rocks were in sight.

Phoines.—In his "Geology and Physical Geography of Victoria," Mr. Reginald Murray refers to a dark-colored and dense greenstone which is exposed in the bed of McPherson's Creek. In outward appearance it much resembles the rocks from the neighboring locality of Carapook, though less fissile and perhaps even fresher looking. In microscopic slides it shows much sanidine, generally in lath-shaped, and, rarely, tabular crystals; the latter, however, when they occur, are exceptionally clear and pellucid. There is also abundance of brown, and a very little green augite. Other minerals may be present, but I have not had time to study this interesting rock as closely as it deserves.

With regard to the geological age of the trachytoid series of rocks in this district I have little to add to what I said before. The tuff containing *Otozamites*, mentioned in my former paper, accompanies a dense rock, which, though it certainly contains some sanidine, departs a good deal from the Carapook type of volcanic rocks. Its specific gravity, viz., 2·87, is, besides, high for a trachyte, and suggests rather a basalt which may belong to a later date than the more acid rocks herein discussed. The

latter, if really younger than the mesozoic strata, which I doubt, must have covered them in some part of the area. Certainly, volcanic rocks, as widely spread as these have been shewn to be, cannot have consisted of dykes only, but must also have flowed out in sheets. In certain places, as at Nareen, Wando Dale, Grit Jurk, Carapook, and Killiecrankie, the underlying rocks are of course visible, and consist either of granite or the fundamental crystalline schists of the area.

EXPLANATION OF PLATE I.

Fig. 1.—A slice from Little Rock, Brit Brit, shewing a mass of small sanidine crystals with large macroscopic ones in the centre of the field. Polarized light, nicols crossed.

Fig. 2.—Typical trachytic rock from Carapook with a porphyritic twin crystal of sanidine. Polarized light, nicols crossed.

Fig. 3.—Typical trachytic rock from Carapook. The main mass of the rock is sanidine, and scattered through it are columnar crystals of probably augite. Ordinary light.

Fig. 4.—Trachytic rock from Phoines, near Carapook, with sanidine and brown augite. Ordinary light.

All magnified 28 diameters.